POKHARA UNIVERSITY RESEARCH CENTER
LEKHNATH-12, KASKI
NEPAL

Faculty Research Grant for Affiliated Colleges (FRGAC)

APPLICATION AND PROPOSAL

Rabindra Adhikari
Cosmos College of Management and Technology.

Pokhara University Research Center
Dhungepatan, Lekhnath,
Kaski

Faculty Research Grant for Affiliated Colleges (FRGAC)

Application form

To be filled by PURC
Date of Submission:
Approved By:

1. General Information

A1. School/College	Cosmos College of Management and Technology	
A2. Faculty	Science and Technology	
A3. Category (Please Tick)		
	1. Humanities & Social Sciences	
	2. Health Sciences	
	3. Engineering	x
	4. Management	
Specify the other Category		
A4. Title of project	Evaluation of Prevalent Retrofitting Techniques in School Buildings of Nepal	
A5. Area of specialization of study	Structural Engineering	
A6. Proposed duration in months	10 months	
A7. Proposed starting Date	Feburary 1, 2018	

2. Principle Investigator/Team leader's information

B1. Full Name		RABINDRA ADHIKARI	
B2. Gender	Male	B3. Specialization	Structural Engineering
B3. Date of Birth	1986-07-30	B4. Highest Degree	M.Sc.
B5. Citizenship	93736	B6. Job Position	Associate Professor
B7. Contact No.	985-123-55-22	Email Add.	rabindraadhi@gmail.com

B8. Academic Records **(Bachelor onwards of latest first)**

Degree	Passed Year	Major group/Subjects	Division/ Grade	Percentage	Board/University
M.Sc.	2011	Structural Engineering	Distinction	86.7 %	TU
B.E.	2010	Civil Engineering	Distinction	80.7 %	TU
+2	2005	Science	First	73.6 %	HSEB
SLC	2003	-	First	71.5 %	Nepal Govt.

B9. Principle Investigator/Team Leader's employment record					
Period of Service		Designation	Employments Name	Address	Temporary/ Permanent
From	To				
2017	Current	Assoc. Prof.	Cosmos College	Lalitpur	Permanent
2016	2017	Add. Assoc. Prof.	Cosmos College	Lalitpur	Permanent
2011	2016	Assist. Prof.	Cosmos College	Lalitpur	Permanent
2010	2011	Lecturer	Cosmos College	Lalitpur	Permanent

B10. Principle Investigator/Team Leader's Research experience			
Title of Study	Employer/University/ Any Other Agency	Contribution	Duration
X			
X			
X			
X			
X			

B11. Principle Investigator/Team Leader's Publication Record		
Date of Publication	Title	Publisher
April, 2016	Comparative Analysis of RC and CFST Buildings in Nepal	ICEE-PDRP 2016
April, 2016	Seismic Vulnerability Assessment of Masonry Buildings in Kathmandu	ICEE-PDRP 2016
October, 2013	Development of Sustainable Rural Cold Storage System in Nepal	RETRUD-11

C1. Co investigators/ Team Members Record

Full Names	
1. Bijay Bishwakarma	4. x
2. x	5. x
3. x	6. x

C2. Co investigators/ Team Members Academic Record (Bachelor degree onwards of latest first)

(1. Bijay Bishwakarma)

Degree	Passed Year	Major group/Subjects	Division/ Grade	Percentage	Board/University
BE	2071	Civil Engineering	First	3.51 CGPA	Pokhara University
10+2	2066	Science	First	74.9 %	HSEB
SLC	2063	-	First	77.4 %	NG

Each member fills in separate table.

B11. **Co investigators/ Team Members Publication record**		
Full Name of Investigator		
Date of Publication	Title	Publisher
X		
X		
X		
X		
X		

Each member fills in a separate table.

D1. Previous faculty research fund record				
Full Name of Investigator				
Year	Title of Project	Total Budget	Project start time	Current status
X				
X				
X				

Each member fills in a separate table.

E1. Scope of involving University Students in the proposed research
Please specify precisely how university students would be involved in the research project.
Final year Civil-Engineering Students will be trained to collect the field data of the selected buildings, after which they will conduct field survey of the selected building structures. Information on architectural dimensions, structural components, their sizes, connections, damage details after the earthquake along with questioners and interview with school representatives will be conducted by the students. Some parts in processing of data like structural modelling and analysis will also be supported by the students.

F1. Collaboration of other institution (If applicable)
Please mention the nature, extent and need of collaboration with other Institutions and their specific role. Give name, address, e-mail ID and Tel no. of the Institutions. Please attach supporting letters of the collaborating Institutions.
This work needs support from Department of Education and other consulting organizations who were involved in original design and supervision of the retrofit works. As the principal investigator has already worked with many of such organization, the related information can be obtained. However, the university shall provide a letter to the researcher asking the concerned organization to provide related information and drawings for the research purpose.

2. Detailed Proposal

The proposal should be clear, concise, well-structured and to the point document with a focused title that communicates the purpose of the study.

(Limit it within 10-12 pages and prepare the Proposal in given format using following as the major components)

Section -I

1. Research Title

Evaluation of Prevalent Retrofitting Techniques on School Buildings in Nepal.

2. Introduction

2.1 Background of Study (Maximum of 500 words)

Many school building suffered heavy damage due to Gorkha Earthquake, 2015. However, some of the buildings were already retrofitted before the earthquake and didn't get much damage. However, there are some damages which needs to be evaluated against the intensity of earthquake it was exposed to, to predict its performance under design earthquake. As the similar method of retrofitting is being practiced in present days as well, the evaluation of those buildings will give useful information to judge its effectiveness and ways to improve it.

3. Research Objectives / purpose / aim of the study:

3.1 General

The general objective of this research work is to evaluate the effectiveness of prevalent retrofitting methods for RCC and Masonry School Buildings in Nepal.

3.2 Specific

1. Identification of retrofitting methods in the building.
2. Vulnerability assessment and post-earthquake damage evaluation
3. Performance evaluation of the structure and identification of defects in the retrofitting system/ components.
4. Recommendations for the improvement in the retrofitting system.

4. Rationale/ Significance of the Study

25th April, 2015 Earthquake cause damage to more than 7700 schools and 20,000 school buildings. However, majority of them lies in rural areas with limited physical and human resource for suitable intervention. In most of the cases similar approach of retrofitting like splint and bands or RC jacketing methods are used for the retrofitting without much knowledge in the methods of its action. So, common defects in using such methods and its suitability needs to be evaluated in realistic manner for its improvement and effectiveness. Thus, this work is necessary to evaluate the common retrofitting methods. However, this work will be limited to school buildings as the sufficient retrofitted building samples are available for school buildings only.

5. Literature Review

School buildings in Nepal are usually categorized as public and private schools. Public schools are usually government funded and constructed, however private schools are usually constructed from the private sector or in most of the cases, and residential buildings are used as school buildings. Until 2014, 165 school buildings in Kathmandu valley were retrofitted using various retrofitting techniques (Dixit et al. 2014). Moreover, after the Gorkha earthquake, school building strengthening is more highlighted due to the raised concern over the seismic safety as well as performance scenario of schools. None to the best of our knowledge has performed an exhaustive seismic performance comparison between retrofitted and non-retrofitted school buildings, thus it should be considered as the first work in Nepal.

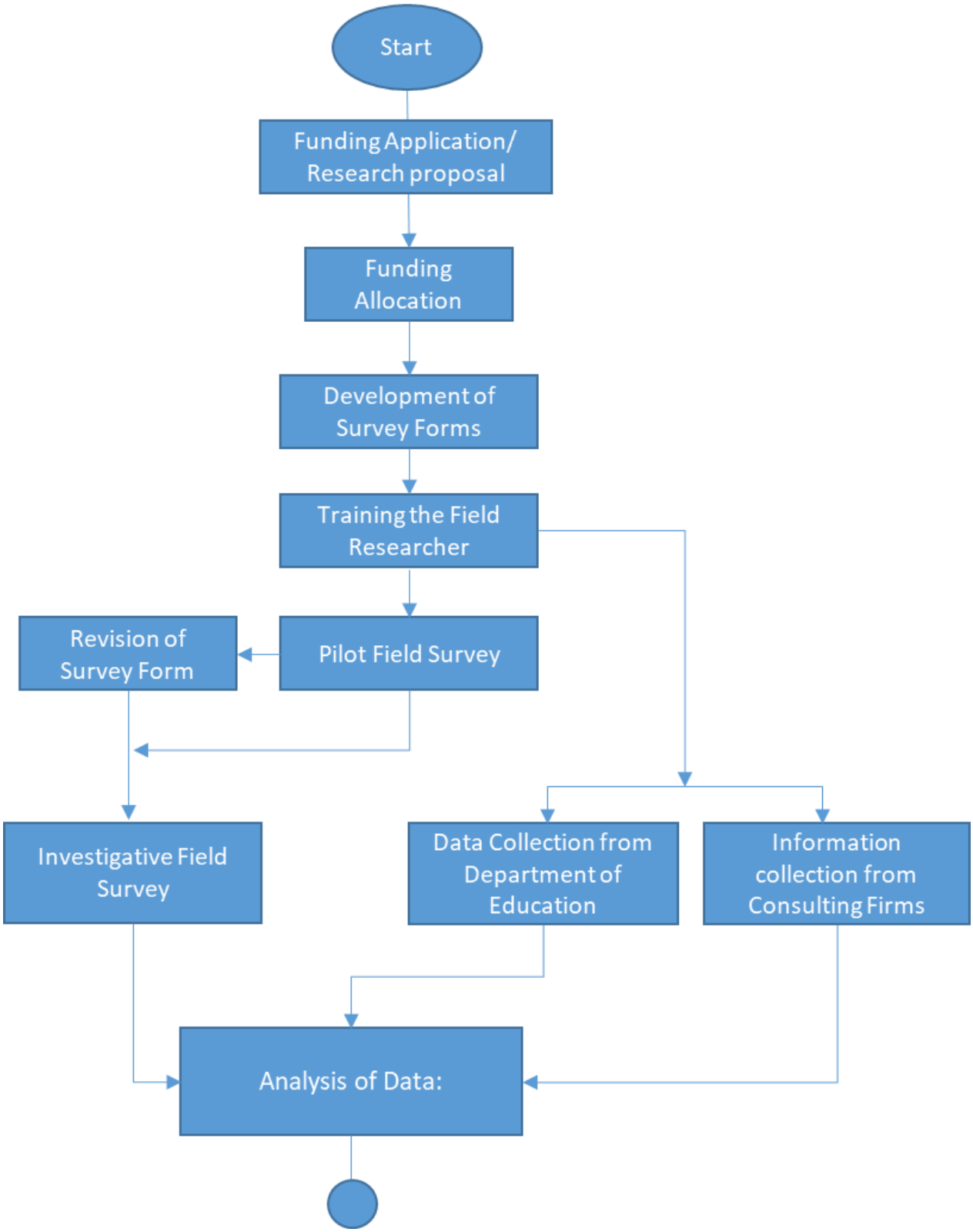
Although comparison scenario is not surfaced yet, Adhikari and Gautam (2017) developed fragility functions, and damage probability matrices for the school buildings as well as building components considering three building classes: reinforced concrete, brick masonry, and stone masonry. Their work is based on 18000 damage figures collected after the Gorkha earthquake in the 14 crisis-hit districts.

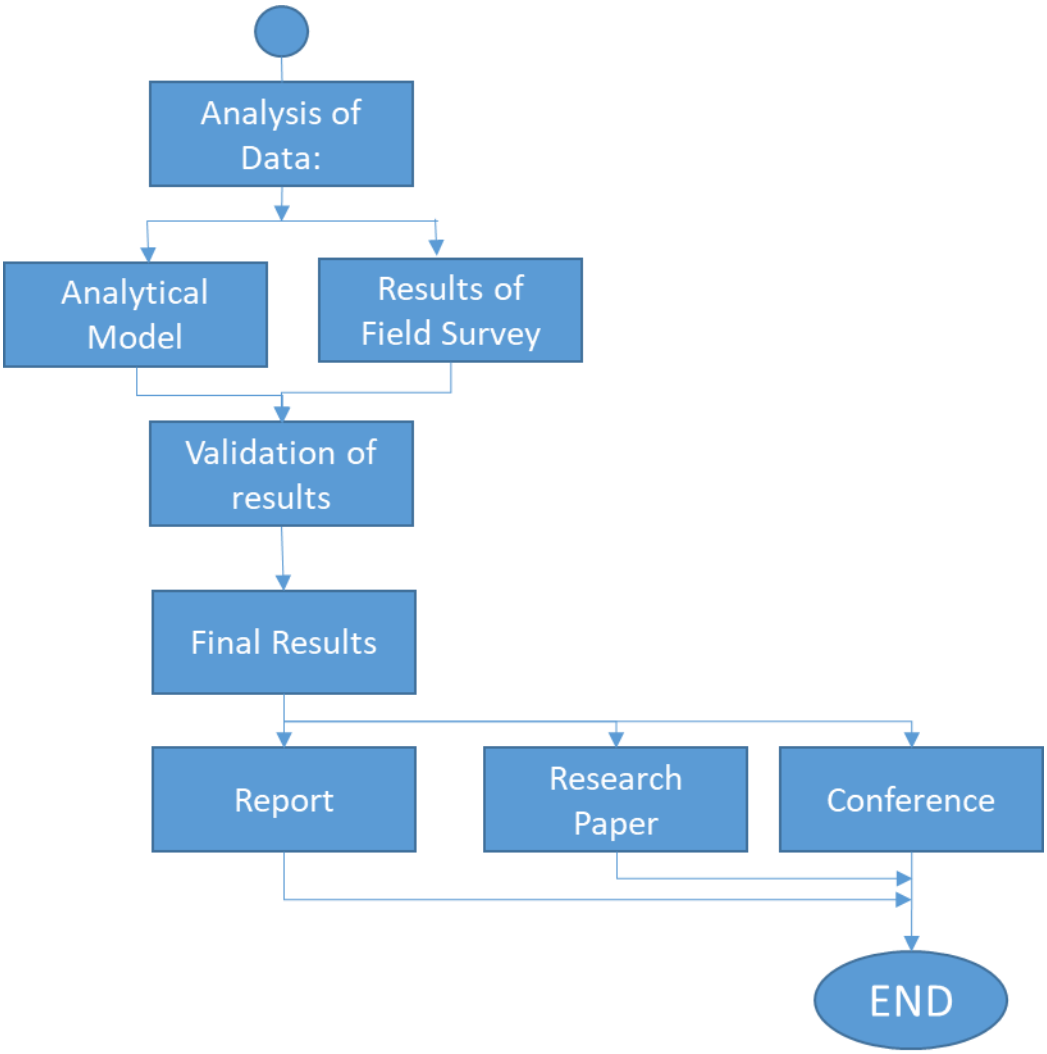
After the Gorkha earthquake, Bose et al. (2016) depicted the LiDAR based damage scenario due to torsional response for a RC school building in Kathmandu.

After the Gorkha earthquake, the damage mechanisms of school buildings together with the residential buildings were also reported by Gautam and Chaulagain (2016), Gautam et al. (2016), Varum et al. (2018), Gautam (2018). Meanwhile, the historical damage scenario of schools and residential buildings is reported by Chaulagain et al. (2018).

6. Research Methodology

This research includes both field investigation and computer based extensive analysis of building structures. The overall methodology of the research can be explained with the following flow chart. The details in research is also explained in section 6.1 through 6.6. Final year students will work as field researcher. Two teams comprising 2-3 members


Start
Funding Application/ Research proposal
Funding Allocation
Development of Survey Forms
Training the Field Researcher
Revision of Survey Form
Pilot Field Survey
Investigative Field Survey
Data Collection from Department of Education
Information collection from Consulting Firms
Analysis of Data:



6.1 Research Design and Study Variables

The research includes following study variables:
Building Typology; Retrofitting Methods; Building Size and Geometry; Earthquake Intensity; Soil properties

6.2 Study Area (If applicable)

The study relates to applied science, with both qualitative and quantitative evaluation. While, the performance of the structure is studied in quantitative scale in relation to other study variables, different defects in the retrofitting works will be studied in a qualitative scale to identify implementation complexities, durability, conspicuousness, and harmfulness.
Reinforced concrete and masonry school buildings from Kathmandu valley will be accounted in the study.

6.3 Sample Size and Sampling Procedure (If applicable)

Out of about 165 schools in Kathmandu valley, 50 buildings will be studied selected based on accessibility and spatial distribution over the valley. Selected buildings shall be distributed over the valley to represent different earthquake intensities, different building geometry, different soil properties, different retrofitting methods, and different structural typology. Although assessment of all the buildings will be better, 50 data will give a good reflection of the population covering almost 30 %.

6.4 Data collection tools /techniques/methods (Specify)

Data are collected through (a) Field Measurement, (b) Field Interview, (c) Revision of pre-assessment data that are available from department of education, (d) Revision of design and drawings from concerned consulting organizations.
Drawings, sketches, measurements, photographs, checklists, and recording of relevant information will be made for the documentation of the data.

6.5 Validity and reliability of study tools

Standard form developed by DUDBC/FEMA, SIDA (The World Bank), and information recommended by Nepal National Building Codes and Retrofitting Guidelines will be used. The drawings, approved by department of Education will be relied upon for identification of previous retrofitting. The recorded performance of selected buildings would be compared with the analytical based model results.

6.6 Data analysis and management

While paper forms will be used in the field to record data, they will be digitized in computer spread-sheets. Microsoft excel will be used for raw data recording and basic analysis, while SPSS will be used for complex statistical analysis of study-variables. We will use SAP2000 program for analytical modelling of the structure for the performance evaluation.

7. Limitation

The study will be limited to school buildings of Kathmandu valley only, as other category of buildings have insufficient number of retrofitting for the analysis. Further, the field study will be limited to linear measurements, visual inspection, and non-destructive tests, to estimate strengths, damage, and deteriorations.

8. Expected Outcome

The study will identify the common defects in the existing retrofitting practices and provide recommendations to improve its effectiveness, sustainability, easiness in implementation and reliability. The performance of the existing retrofitted buildings will also be evaluated that assist future DRR plans in the schools.

9. Plan for dissemination

First hand findings and deductions will be disseminated through a seminar or conference. Then with the feedback, further analysis, a journal paper will be prepared that will be published in recognized national or international journal.

10. Work Plan (should include duration of study, tentative date of starting the project and work schedule)

February-1, 2018: Start of the Project
February: Training for field-evaluation
March+April: Data collection (a) from field (50 buildings); (b) from department of education; (c) from consulting organizations.
May+June: Analysis of Data
July+August: Analytical Modelling
September: Conclusion Deduction, Seminar, Submission of report to University
October+November: Finalizing, preparing journal paper for publication

11. Budget

Provide with a tabular form of detailed information related to the cost of this study including university fee, field works, experimentation, books, study visits, seminar disseminations, printing and stationary, equipment, computers, and so on. Also mention the various sources of funding your research and available facilities, if the financial contribution provided by PURC may not be sufficient to meet all your study expenses.

1. Preparation and Printing of Field-Forms: Rs. 5,000.
2. 1 day training to field researcher: Rs. 5,000.
3. Pilot data collection (4 buildings in 2 days): Rs. 10,000.
4. Field visit (46 building, 25 working days): Rs. 50,000.
5. Organization of seminar: Rs. 25,000.
6. Contingencies: Rs. 5,000

Total Expected Budget: 1,00,000 (NRS. One lakh only.)

12. References (Harvard style)

1. R. Adhikari and D. Gautam 2017. Fragility Based Seismic Vulnerability Analysis of School Buildings in Nepal subsequent to 2015 Gorkha Earthquake sequence, Journal of Earthquake Engineering.
2. A.M. Dixit, R. Yatabe, R.K. Dahal and N. P. Bhandary 2014. Public School Earthquake Safety in Nepal, Geomatics, Natural Hazards and Risk, 5:293-319.
3. S. Bose et.al. 2016. Structural Assessment of a School Building in Sankhu, Nepal, Damage due to Torsional Đ Response during 2015 Gorkha Earthquake, Engineering Non-linearities in Structural Dynamics.
4. FEMA 273.
5. Nepal National Building Codes.
6. D. Gautam and H. Chaulagain 2016. Structural performance and associated lessons to be learned from world earthquakes in Nepal after 25 April 2015 (M_W 7.8) Gorkha earthquake. Engineering Failure Analysis 68:222-243.
7. H. Chaulagain, D. Gautam and H. Rodrigues 2018. Revisiting major historical earthquakes in Nepal: overview of 1833, 1934, 1980, 1988, 2011 and 2015 seismic events. In: D. Gautam and H. Rodrigues (eds.), Impacts and Insights of the Gorkha Earthquake, Elsevier, pp. 1-17.
8. H. Varum, R. Dumaru, A. Furtado, A. Barbosa, D. Gautam and H. Rodrigues. Seismic performance of buildings in Nepal after the Gorkha earthquake. In: D. Gautam and H. Rodrigues (eds.), Impacts and Insights of the Gorkha Earthquake, Elsevier, pp. 47-63.
9. D. Gautam 2018. Past and future of earthquake risk reduction in Nepal 2018. In: D. Gautam and H. Rodrigues (eds.), Impacts and Insights of the Gorkha Earthquake, Elsevier, pp. 173-182.
10. D. Gautam, H. Rodrigues, K.K. Bhetwal. P. Neupane and Y. Sanada 2016. Common structural and construction deficiencies of Nepalese buildings. Innovative Infrastructure Solutions, 1:1, doi: 10.1007/s41062-016-0001-3

Undertaking by the Principal Investigators/ Team Leader

It is solemnly affirmed that I have read and understood the conditions of the award of this program advertised on the Pokhara University Website and that the decision of the PURC would be final and binding. In the event that my progress as the team leader of the project is found unsatisfactory in the periodic evaluation during the period of our study, I shall be liable to disciplinary action which may result in termination my involvement in this project.

Name: Rabindra Adhikari

Date: 31st Dec, 2017 Signature: